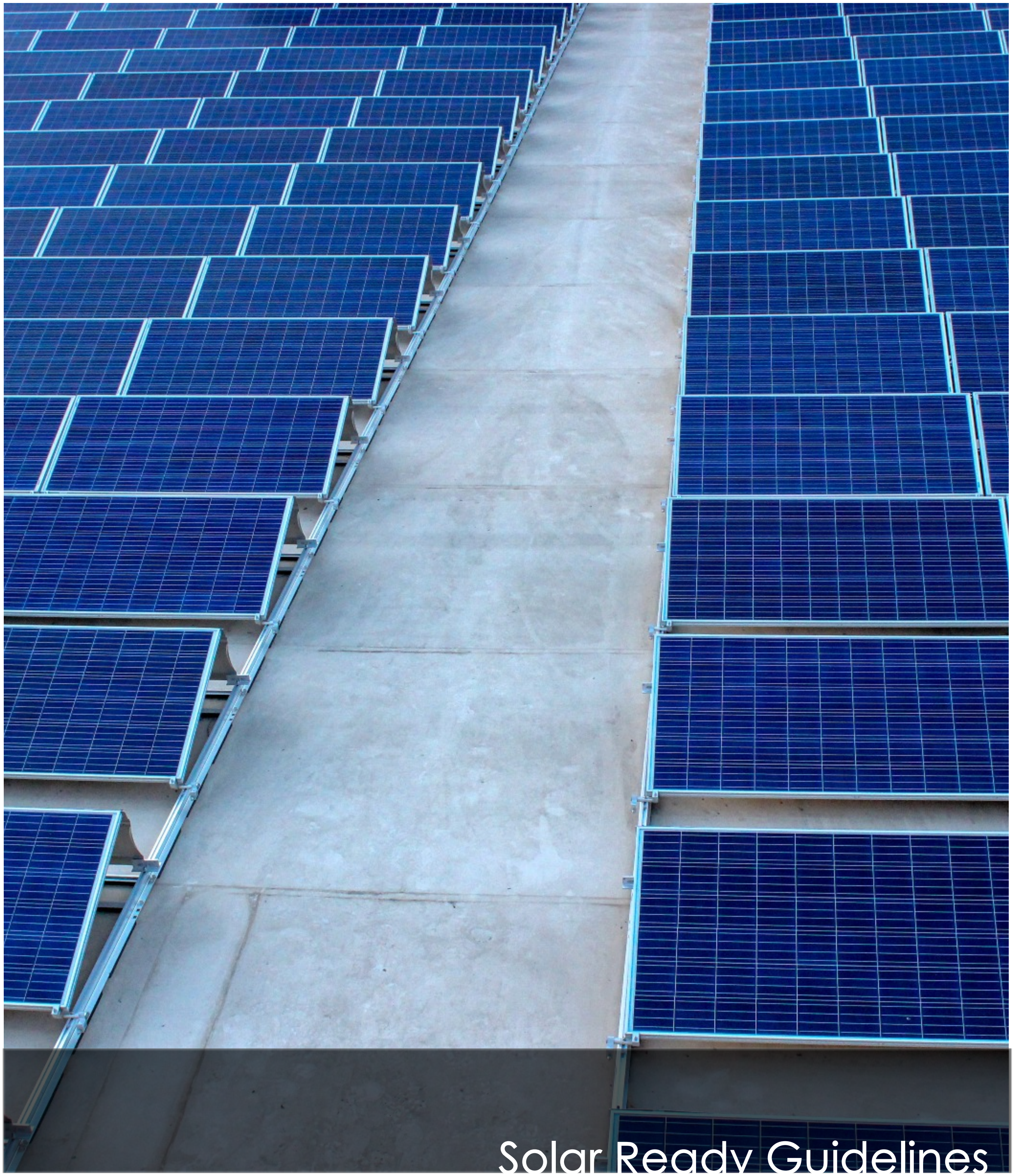
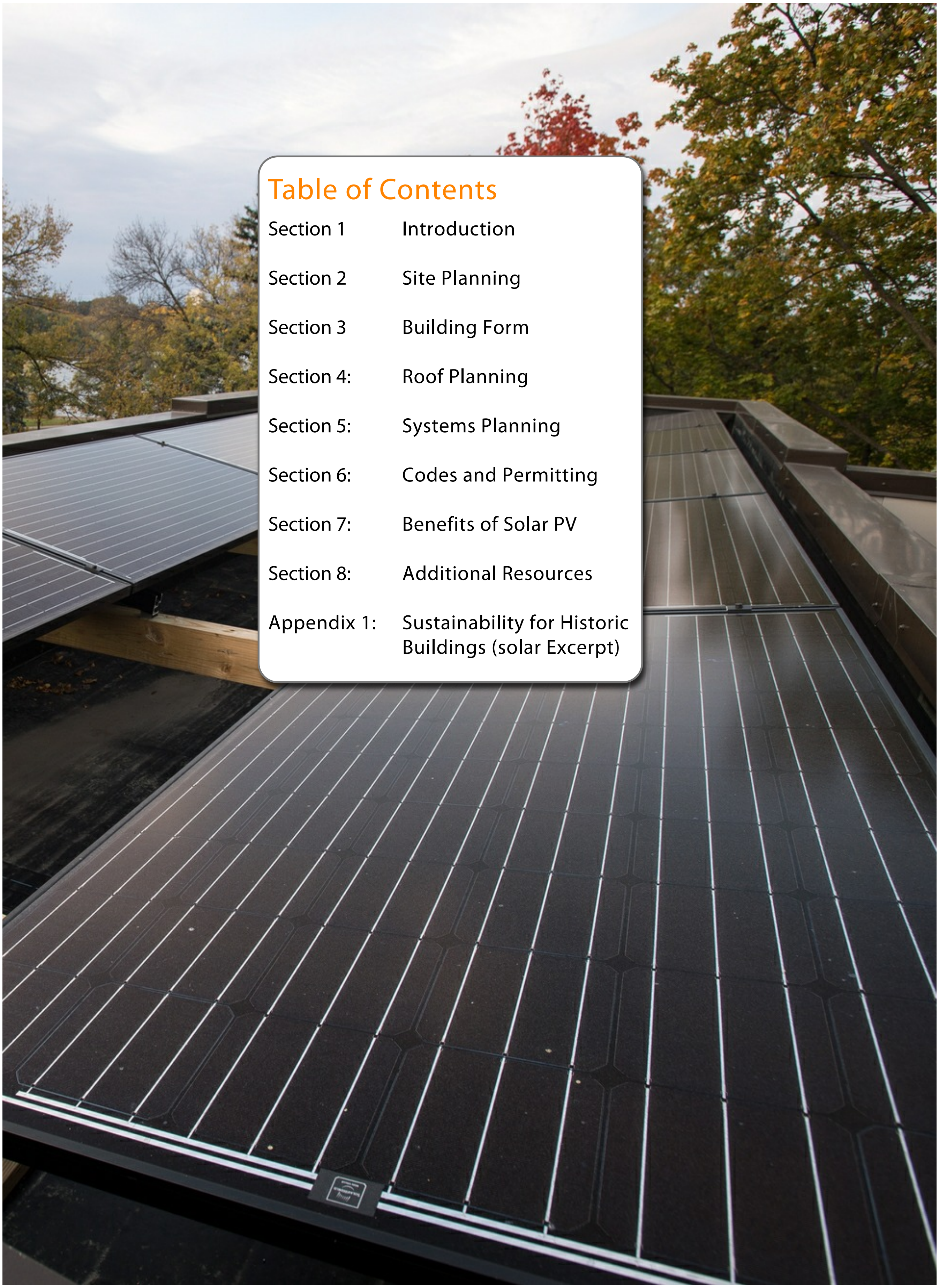


Solar Ready Guidelines

February 2020 **Prepared by:**

CITY OF EAU CLAIRE

making change personal paleBLUEdot LLC



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Introduction

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> By having the SolSmart designation at this elite level sends a signal to those folks that are aware in the solar industry that, OK, Eau Claire is a place that embraces solar that makes it effective to do that work here.
>
> Ned Noel, City of Eau Claire, Associate Planner

Introduction

Purpose
The purpose of this City of Eau Claire Solar Ready guideline are to encourage long-term solar development within the community as well as by building owners to establish building performance expectations to share with architects and contractors with any future building construction project. This document is educational and does not replace, supersede, or represent State or City codes and ordinances. Contractors, designers, and building owners should become familiar with the requirements of all relevant building codes and ordinances.

Background
The City of Eau Claire has committed to transition away from a fossil fuel-based economy. In March 2018, the City established long-term goals of achieving 100% carbon neutrality and 100% renewable energy community-wide by 2050. In order to undertake this effort, the City has undertaken to develop the Renewable Energy Action Plan (REAP) to lay out a pathway to meet the City's goals, including the increase of renewable energy generation and solar power installations throughout the City. This guide will help the community fulfill those objectives. The following REAP strategies relate to the information provided in this Solar Ready Guideline document:

R8: Increase privately owned solar. Promote on-site rooftop or ground-mount solar within the city.
Goal: 50 new systems per year (425,000 kWh per year)

R11. Increase the number of solar-ready buildings in residential new construction. Incentivize or require residential homes that are built to install rooftop solar to avoid future retrofit, through tactics such as this solar-ready guide, offering incentives, and exploring state-level code changes.
Goal: Develop incentive offering within four years and build 25 solar ready homes per year

C7. Increase the number of on-site customer-owned solar photovoltaic installations at existing buildings and sites. Educate and consider policies to encourage businesses to install rooftop, parking lot, or other on-site solar.
Goal: Five new installations each year (802,500 kWh per year)

C8. Increase the number of solar-ready buildings in commercial, industrial, and institutional new construction. Use communication channels such as this solar ready guide, and explore policy options to encourage solar-ready design in new construction and major renovations.
Goal: 10% of new construction and major renovation projects are solar-ready by 2025

SolSmart Designated Community
The City of Eau Claire is a US Department of Energy SolSmart Gold designated community. SolSmart communities have developed policies and ordinances to make it easier, faster, and more affordable to go solar. Eau Claire was specifically awarded special designation in strong planning, community, and utility engagement and is ranked 16th nationally.

For additional information on the City's SolSmart Designation visit:
https://www.solsmart.org/communities/eau-claire-wi/

For the City's solar permitting process and ordinance information, visit the City's solar resource page:
https://www.eauclairewi.gov/government/our-divisions/sustainability/solar

Introduction

What is Solar Ready?

A Solar Ready building is engineered and designed for solar installation, even if the solar installation does not happen at the time of construction. Solar Ready design is important if photovoltaic (PV) or solar hot water (SHW) technologies are to be installed on a building at any time during the building's lifespan. Solar Ready also allows owners to take advantage of a changing energy market more easily and less expensively in the future.

By 2018, the costs for on-site solar pv installations had dropped 65% over the costs just a few years earlier. Projections for solar pv anticipate continued increasing cost efficiency, while State and local renewable energy policies continue to come 'on line' which both encourage renewable energy as well as improve the economics of on site renewable energy generation. Making a building Solar Ready enables a building owner to take advantage of cost effective on-site renewable energy generation in the future, even if the current economics for on-site solar are not yet persuasive for a specific site, continued advancements in system technology and public policy are very likely to make on-site solar a choice for most buildings.

Why Implement Solar Ready Guidelines?

One of the largest barriers to the installation of solar energy systems is the traditional building design. Most existing buildings were built without consideration for the potential of on-site solar energy generation.. Roof structure, building orientation, location of mechanical systems and other building design elements can often make the installation of solar energy systems significantly more complicated and expensive than it would have been if these features were simply designed with solar in mind. Even new buildings often require substantial retrofits to take full advantage of the building's available solar resource, which is why new building solar ready guidelines are needed.

With a few relatively easy changes, it is possible to build solar ready buildings with electrical and mechanical features that help to streamline the integration of solar systems. With a few relatively simple improvements in design and construction, solar systems can be installed with little, if any, structural modifications. For non-residential buildings, it is estimated that the addition of solar readiness could add approximately $2,000-$7,500 to new project construction costs, while retrofitting existing structures to incorporate solar readiness is estimated to cost $20,000-30,000 dollars (Minneapolis, St Paul Solar Cities Program 2010).

How Do Solar Ready Guidelines Work?

Early consideration of these guidelines can help ensure the easy installation of future photovoltaic systems. Solar Ready guidelines are straightforward and focus upon the following general areas related to building design:

- Roof pitch and orientation
- Layout of roof vents, chimneys, etc., to prevent shading
- Roof load bearing specification
- Designated roof mounting points for PV array
- Installation of electrical conduit from main electrical panel location to roof
- Specification of main service panel and circuit breakers
- Space near the main electrical panel for PV inverters and other equipment

Note:

These guidelines are intended as an educational resource to assist building owners, designers, and contractors in making future solar installations as easy and cost effective as possible. This document does not replace, supersede, or represent State or City codes and ordinances. Ratified building codes and ordinances shall govern in any apparent or potential conflict with any of the information provided in this guide document. Contractors, designers, and building owners should become familiar with the requirements of all relevant building codes and ordinances.

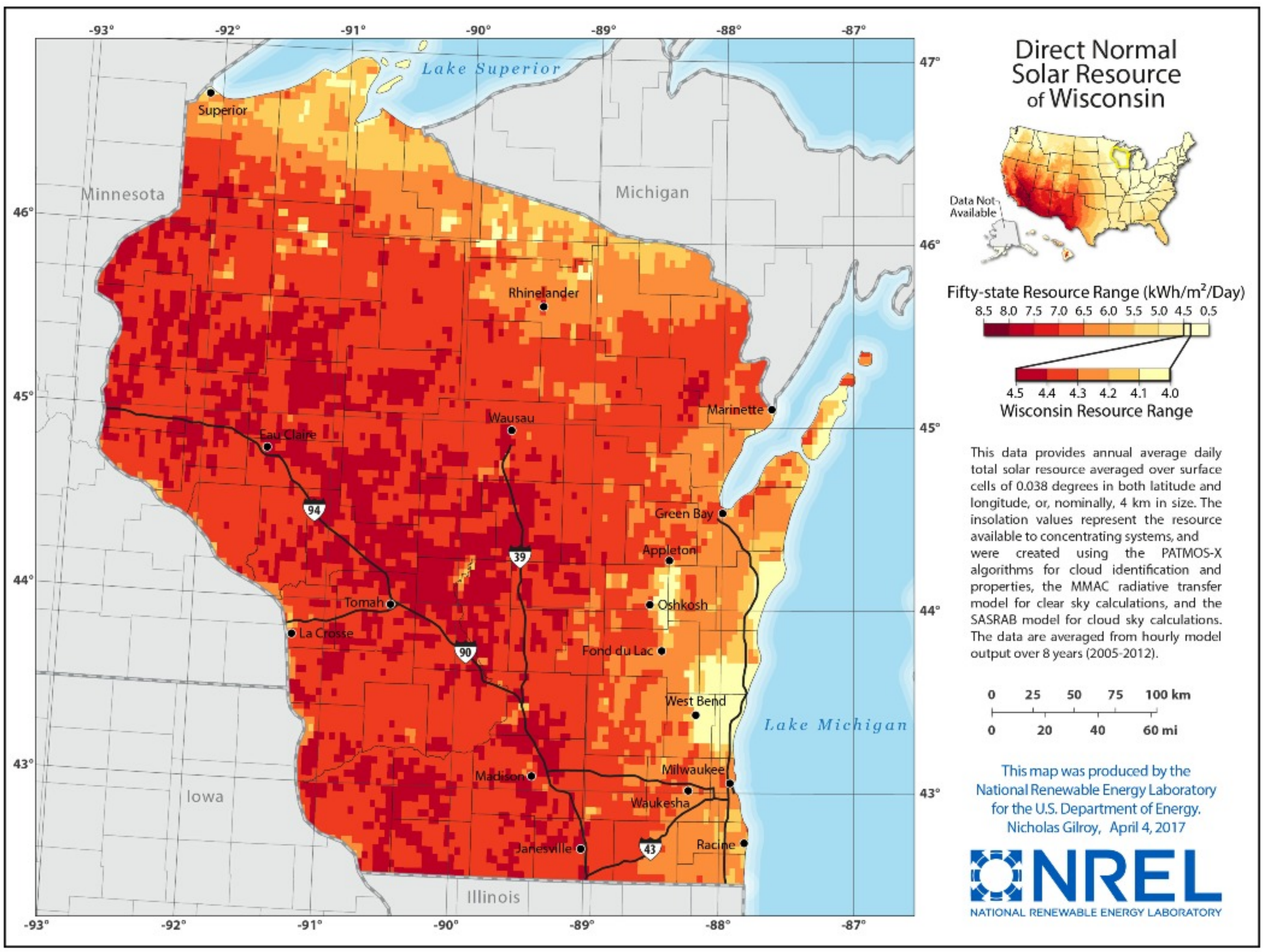
Introduction

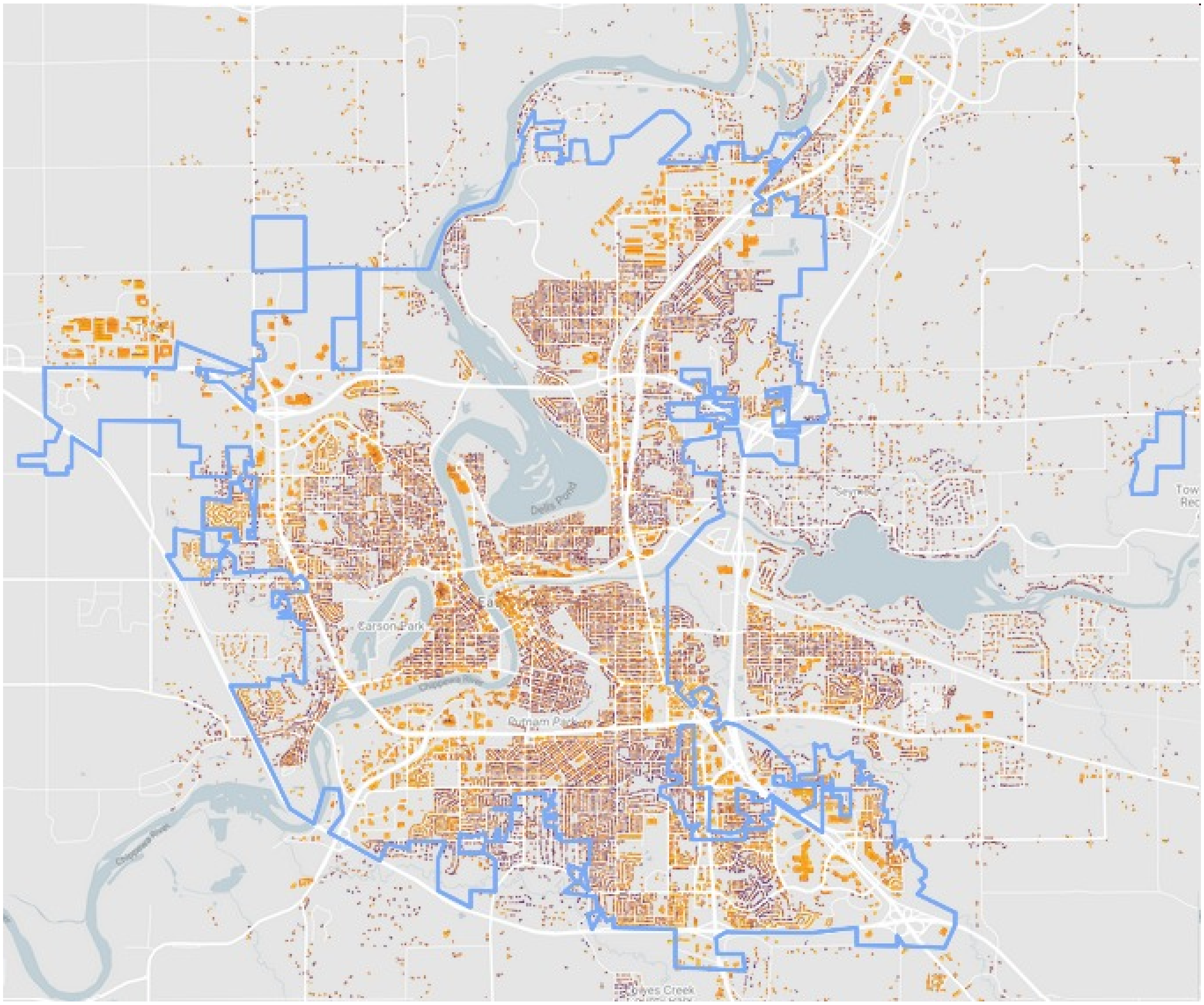
Solar Resources

Solar Irradiance is a measure of how much solar power you are getting at your location. This irradiance varies throughout the year depending on the seasons. It also varies throughout the day, depending on the position of the sun in the sky, and the weather.

Solar insolation is a measure of solar irradiance over of period of time. Insolation can be measured in the average electricity production potential by area per day (Kwh/m3/day). The insolation of different geographic locations have already been calculated based on satellite data which makes it possible to estimate and compare the amount of solar energy available at different locations during different times of year.

You can find State wide solar resource maps for the entire united states at: https://www.nrel.gov/gis/solar.html Using this information, you can estimate the total annual solar electricity potential of any surface. Simply take the average solar resource shown for Wisconsin (in the image below, the average solar resource is 4.5 KWH/m3/day) and multiply that by the area of your potential solar array - the result will be the estimated average daily solar pv electricity generation for your location. Multiply that number by 365 for an estimate of the total annual output. Using this method will produce a reasonable preliminary estimate of annual electric potential for your site. Google Project Sunroof is an online tool which can provide a high-level preliminary estimate for existing buildings (https://www.google.com/get/sunroof). For more detailed projections, there are a number of modeling programs available, including PVWatts (https://pvwatts.nrel.gov/).





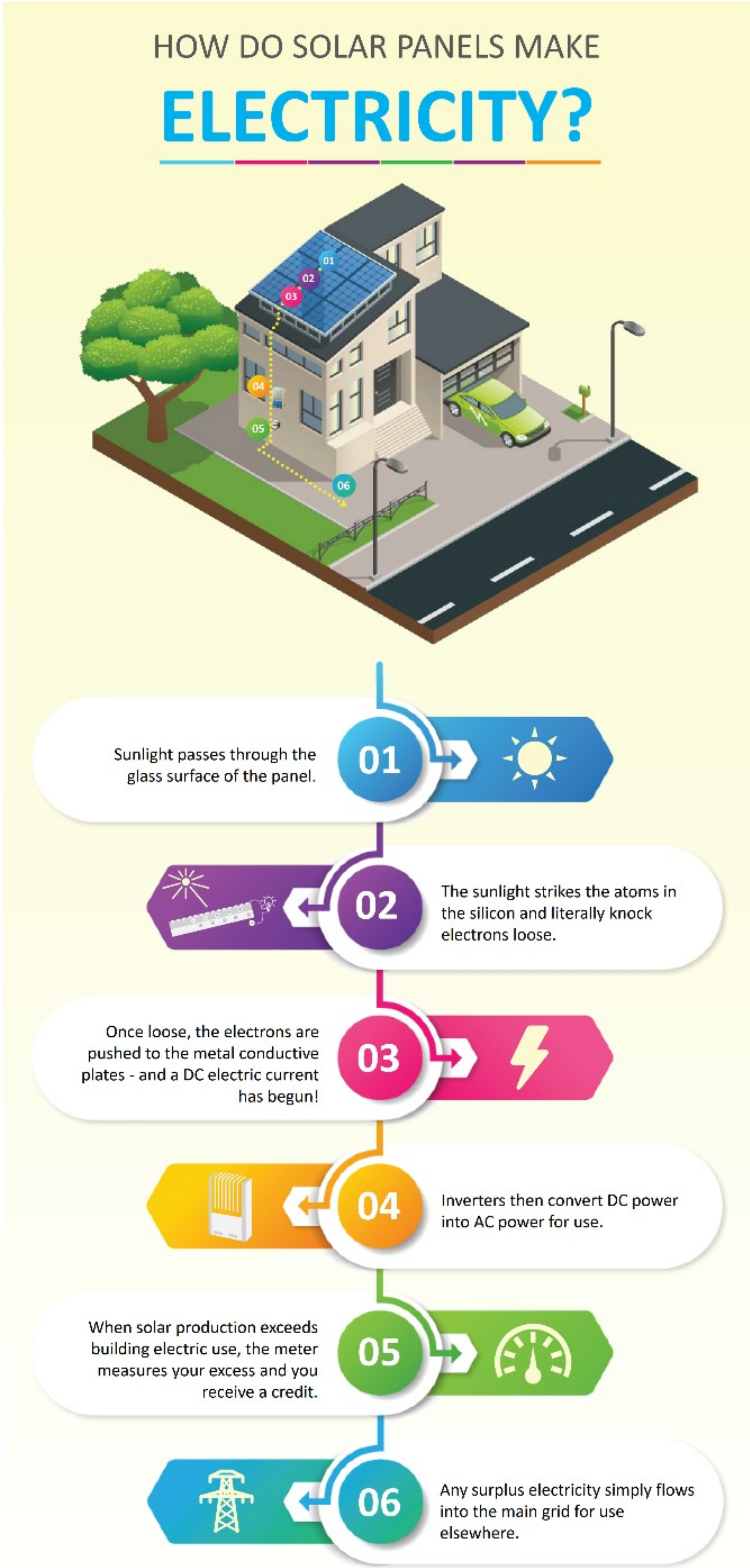
Citywide Solar Resource Map
Source: Project Sunroof data explorer (November 2018).

Total estimated size and solar electricity production of viable roofs for Eau Claire, WI

Roofs	Roofs	
72%	16.6K	
Roof space	**Capacity**	**Electricity**
28.4M sq ft	402 MW DC	449K MWh AC per yr

Citywide Solar Resources

According to Google's Project Sunroof, the City of Eau Claire has 36 existing solar installations, while 72% of the existing buildings (over 16,600 rooftops) in the City are anticipated to be Solar Viable (meaning an economically viable solar array is possible on the building). These 16,600 rooftops are estimated to be capable of generating 449,000,000 kWh annually.



How do solar pv panels create electricity?

Solar PV semiconductors combine some properties of metals and some properties of insulators - making them uniquely capable of converting light into electricity. The simple explanation of how solar panels create electricity is that as sunlight (specifically UV light) strikes the semiconductor materials in the PV cell, the energy knocks loose electrons. Those electrons then move back and forth between semiconductor plates producing an electric current.

How Much Area Do I Need To Generate The Electricity I Use?

The amount of area a solar array will need on your rooftop or ground area will vary somewhat based on a number of factors. Factors impacting the amount of space an array will need for your building site include:

- Average solar insolation your site receives
- Shading conditions of your site
- Solar module used - each has its own maximum capacity and efficiency ratings
- Electrical system components used such as inverters and cables
- Orientation of the array - both azimuth (compass direction) and tilt of the panels
- Configuration of the rooftop or ground area on which the array will be located
- The amount of equipment or obstructions the array must accommodate

Producing a detailed computer model is the best way to anticipate the likely amount of electricity a given solar array can be expected to produce month-by-month or annually. We can, however, use a rule of thumb calculation to estimate the square footage of rooftop or ground area that might be required to meet a building's annual electricity demand.

For Rooftop Arrays:

The following equation can be used to approximate the area required for a flat-rooftop solar array to meet your electric demand (assuming minimal obstructions):

$$E / 1150 \times 170 = Afr$$

The following equation can be used to approximate the area required for a southerly sloped-rooftop solar array to meet your electric demand (assuming no obstructions):

$$E / 1150 \times 110 = Asr$$

Where
E = Buildings annual electric use in Kwh
Afr = Approximate flat rooftop area required for an array meeting that electrical demand.
Asr = Approximate sloped rooftop area required for an array meeting that electrical demand.

For Ground Mounted Arrays:

The following equation can be used to approximate the area required for a ground mounted solar array to meet your electric demand:

$$E / 1150 \times 160 = Ag$$

Where
E = Buildings annual electric use in Kwh
Ag = Approximate ground area required for an array meeting that electrical demand.

Net Metering
Net metering tracks the amount of energy generated on site as well as the amount of energy consumed from the grid. Net metering allows customers to get credit back from excess generation on a bill when the amount of energy a solar panel system generates is greater than the amount of energy consumed from the electric utility. Customers receive payment for the excess energy generated. Such interconnection is considered non-incentivized, meaning that the site/solar array owner will retain the renewable energy credit that the PV system produces.

Renewable Energy Credits
Renewable Energy Credits (RECs) are tradable, non-tangible energy commodities that represent proof that a quantity of electricity was generated from an eligible renewable energy resource. RECs represent all of the "green" or clean energy attributes of electricity produced from renewable resources like solar PV. A REC includes everything that differentiates the effects of generating electricity with renewable resources instead of using other types of resources. It is important to remember that a REC also embodies the claim to the greenness attributes of renewable electricity generation, and only the ultimate consumer of the REC has rights to the claim; once a producer or owner of a REC has sold it, rather than consuming it themselves, they have sold the claim and cannot truthfully state that they are using renewable electricity, or that the electricity that was produced with the REC is renewable.

The owner and user of a Renewable Energy Certificate (REC) is the only party that can claim the environmental benefits of that REC and claim to be using renewable energy because of that REC. Naturally, issues of REC ownership, validity of certain claims and avoiding double counting are central to a robust voluntary renewable energy market.

Many building owners interested in pursuing the installation of a solar pv system on their property are motivated from an interest in using (and claiming) renewable energy for operations. When all such motivated organizations are engaging in the purchase of solar pv arrays or the purchase of solar power, very careful understanding of a project's Renewable Energy Credits and the status of their ownership is critical. Failure to carefully define ownership of REC may cause the inability of a building owner to claim the renewable benefits they wish to obtain.

The Building Owner should assume that RECs will not be available for any projects which are delivered through a "third party" project delivery method, or any project which utilizes a utility subsidized approach. In those project delivery methods, the Building Owner would assume that all RECs will be purchased by a third party or the electric utility as a part of the finalized interconnection agreement. It may be possible for the Building Owner to retain REC credits, however, and it is recommended that the Building Owner explore the retention of all REC credits produced by the recommended projects if financially feasible. For locations in the City of Eau Claire, it is important to note that until the State of Wisconsin issues clarifying legislation there is some uncertainty around third party solar ownership models.

Project Delivery Options
This report assumes all solar pv systems are direct purchase of the Building Owner. Regional solar developers may provide services to building/site owners through alternative project delivery options such as Solar Lease Agreements, Power Purchase Agreements, or "Reverse Lease" agreements for ownership of the Federal Investment Tax Credit benefits. These alternative delivery methods use 3rd party entities for one or more aspect of the procurement and ownership of the solar array and/or Federal ITC tax benefits. Third party project delivery methods frequently have a solar array purchase opportunity at a future date such as in year 7, year 10, or year 20. For the City, the advantage of a 3rd party project delivery is the ability to leverage project savings due to the Federal Solar Tax Credit, currently capable of reducing the cost of a solar pv by up to 26% (2020 tax credit value).

Most Solar Lease Agreements are designed so that the third party, or the power company, retains the RECs produced by a solar array. As such, any entity that is motivated to claim use of renewable energy or to leverage a reduction in their operating greenhouse gas emissions would typically not be capable of making such claims under these traditional third party delivery structures. It may be possible, however, to negotiate a project delivery similar to a Solar Lease in which the site owner could retain the REC's generated by the project.

Section 02

Site Planning

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Site Planning

There are a number of Site Planning considerations which can have significant impacts on the effectiveness and cost-efficiency of solar PV arrays. Overall site suitability, zoning considerations, and solar ready site design are all aspects of an effective solar pv project.

Site Suitability

Not all sites are well suited for solar pv. At the most basic level, a quality site for a solar pv installation will provide the solar array with enough unobstructed access to sun light to support cost efficient generation of electricity.   Common site considerations limiting the suitability of a site for solar pv include:

- Topography: Sites which have significant topographical features adjacent to the site and within the solar path (to the Southeast, South, or Southwest of the site) such as a mountain or large hill may find their insolation levels hampered - particularly in late fall, winter, and early spring months.
- Tree Coverage: Adjacent forested areas, or areas of tree coverage within the subject site, can cast shadows on solar pv sites during daylight hours and negatively impact the productivity of a solar array. Depending on the site size and configuration and the site's electrical demands, shading from on-site or surrounding trees may not pose a threat to the performance of an array.
- Protected Habitats: The presence of protected habitats such as designated wetlands may reduce the available site area for solar pv array placements. Depending on the location of the protected habitat within the subject site, protected habitats may also dictate, or limit, the placement choices for solar pv arrays - which in turn may result in less than ideal site location availability.
- Building Obstructions: Some sites have buildings adjacent to the site within the solar pathway which may cast significant shadows across the subject sites during needed solar energy generation timeframes. When assessing the suitability of a site, it is important to also identify potential future built conditions which may limit the efficiency of a solar array.

In evaluating the potential for Solar Ready Construction, consider the size and orientation of the prospective building sites and the impacts of existing and planned buildings, topography, vegetation, and protected habitats (both on-site and on adjacent sites). A detailed solar obstruction study and array performance model can determine the actual impacts of any of these considerations.

Zoning and Regulations

It is important to be familiar with local zoning laws and how they may impact the installation of solar panels. Common zoning considerations are:

- Limitations on Solar Arrays: Some city ordinances include restrictions on solar pv arrays, such as limitations of ground mounted arrays, or limitations on rooftop array visibility. The addition of solar generation to a building may require conditional use permits or design review with city agencies or city commissions.
- Access to Sunlight: Access to sunlight is not a universally protected property right. In developed or developing neighborhoods, achieving and maintaining solar access may require agreements or easements with neighboring property owners regarding heights of future buildings and landscaping. Some state statutes, like in Minnesota, enable local jurisdictions to address solar access through the use of solar easements.
- Special Districts and Associations: Properties located within historical districts or covered by a homeowners association may be subject to additional restrictions.

City of Eau Claire Ordinances

The City' s Solar Access Regulations And Best Practices brochure provides details on the City's solar ordinances:
https://www.eauclairewi.gov/home/showdocument?id=17821

The focus of creating a solar-ready building, of course, is to anticipate the eventual installation of a solar system. Site planning for a solar ready building, then, needs to identify and anticipate zoning and regulatory aspects of a solar array. By engaging local zoning and building officials, a project team can readily identify what, if any, regulatory needs a future solar pv array may need to meet and plan accordingly.

Site Planning

Solar Ready Site Design

Decisions made regarding site utilization, configuration, and design can support a cost effective solar pv array, or hinder its potential. Common site design considerations for quality solar pv arrays include:

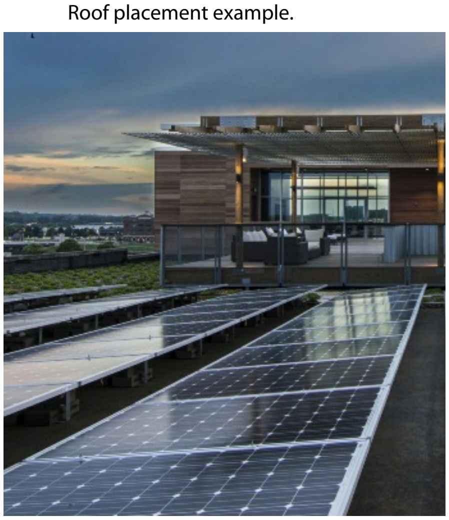
Terrain and space: Roofs, shade structures, and flat open areas are often prime choices. Rocky inclines, or areas of poor soil conditions may have challenges for excavating or mounting. Sufficient room must be present to place the PV array safely and properly without creating any long-term maintenance or safety issues. Site grading should be carefully considered to assure that any anticipated ground mounted solar arrays are not placed in flood planes or flash flood prone areas of the site.

Self Shading: Thoughtful design of a subject site is critical to assure that the placement of buildings, parking areas, and landscape features do not cause self-shading considerations which would reduce or eliminate the effectiveness of a future solar PV. For instance, Large and tall site elements which can be expected to cast significant shading may significantly impact solar pv potential if placed on the South portion of the subject site.

Example of self-shading or shading from neighboring structure. Energy production is completely lost on each panel in shadow.

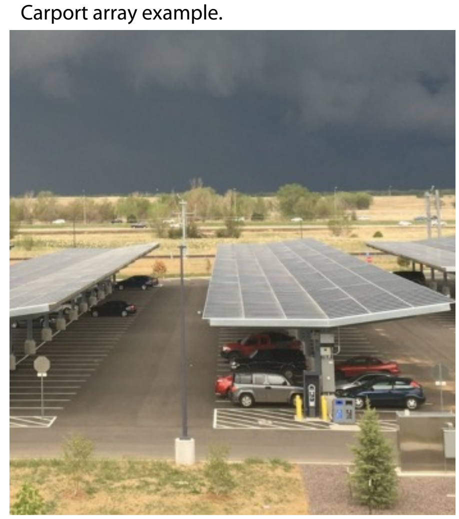
Solar Collector Placement: In many cases, the roof is a good location for a solar PV system. This is a convenient location because it is out of the way and frequently un-shaded. In addition to roof locations, there are many other areas that also make good collector locations. Some of these include parking shade structures (carport arrays), open portions of land within the site, and solar pv integrated into the building envelope and systems. When considering a solar system, all possible locations should be considered and assessed for potential performance.

Roof placement example.



Ground mounted placement example.

Carport array example.

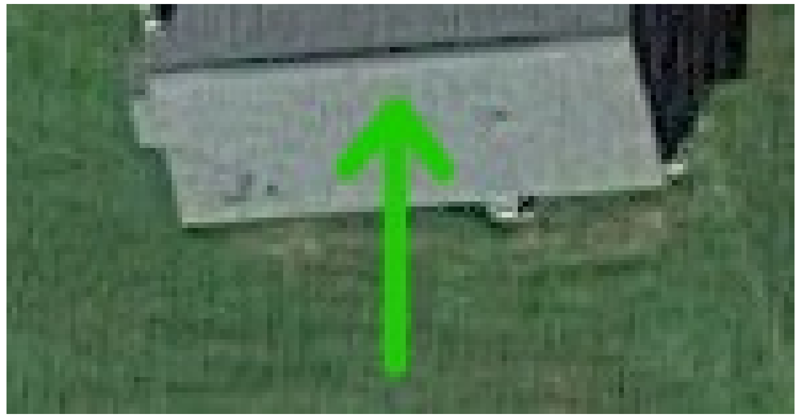


Site Planning

Solar Ready Site Design (continued)

Landscape Elements: Select and design landscape features and plantings to be compatible with solar pv array locations, keeping in mind future growth of natural elements like trees. Select dwarf tree varieties for site locations adjacent to the building which are in the sun path, use low-growth ground covers surrounding ground-mounted arrays, and consider greenscape strategies for parking areas which will not conflict with future carport solar arrays (such as dwarf trees, shrubs, and rain garden assemblies)

An example of Solar Ready landscape elements: No surrounding trees, buildings, or geological features to cast shading on roof surface.



An example of Solar Ready landscape elements: Some surrounding trees, buildings, or geological features to Southeast, South, or Southwest - but none are more than 6' higher than lowest edge of roof for every 12' in distance from roof edge they are. Selection of dwarf or limited growth tree varieties can provide shade for the occupied spaces of a building while retaining the solar value of the roof.

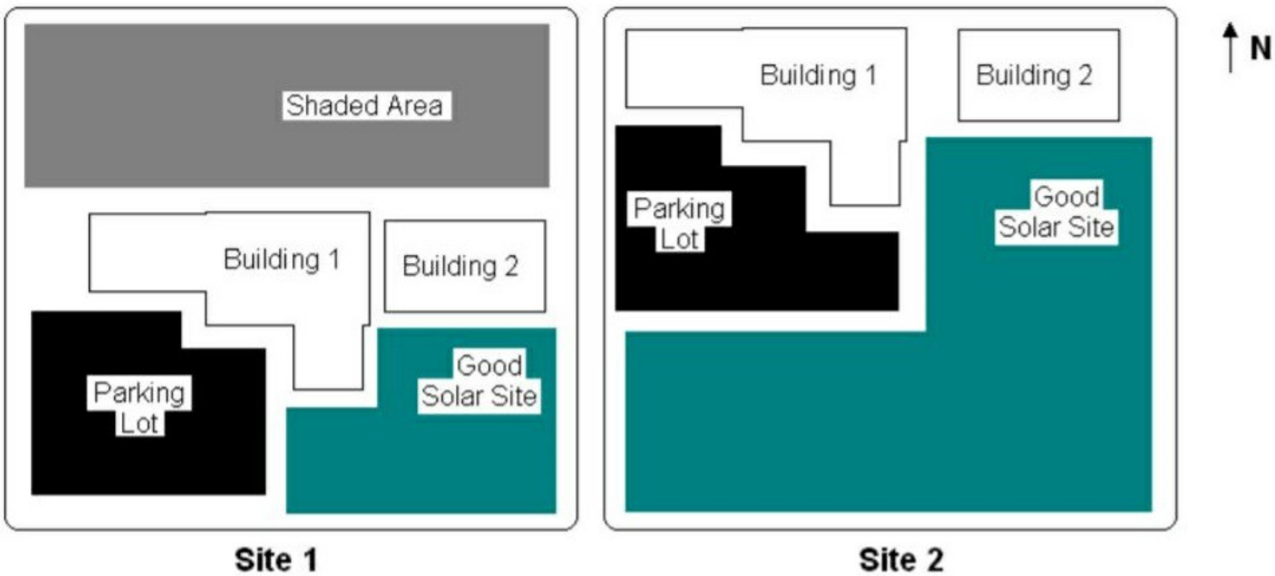
An example of landscape elements that are NOT Solar Ready: Surrounding trees, buildings, or geology to Southeast, South, or Southwest are MORE than 6' higher than lowest roof edge for every 12' in distance from roof.

Site Planning

Site Planning for Solar

At the beginning of project design consider how the site layout can be made to better support a solar system. In most cases, the layout of a site can determine whether a solar system is feasible or not. See the figure below for two example scenarios: In Site 1, a large amount of open space is available north of the buildings, but because of shading from the buildings, the area will be shaded for a large part of the year. In Site 2, the buildings and the parking lot were shifted to the north side of the site. This left the open space on the south side of the site, where shading from the buildings will not fall on the solar panels. By placing the buildings on a site with solar resource and shading in mind, the area available for solar panels can be greatly increased.

(Source: National Renewable Energy Laboratory)



Section 03
Building Form

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Building Form

Solar Ready Building Form

Decisions made regarding plan organization, building massing, building systems configuration, and building orientation can all create a highly suitable site for future solar pv if done properly. Common building organization and form design considerations for quality solar pv arrays include:

Plan Organization: Organize the site and building plan with solar access as a design criteria, making the the location and performance of the solar array an integral element of the building design. Estimate the size of the solar array required based on projected electrical loads (see Introduction). Once a general size is determined, optimize its location on the site, and evaluate building plan options with the array size and optimal exposure in mind to maximize solar array efficiency. Plan organization should also take into account the needed structural considerations.

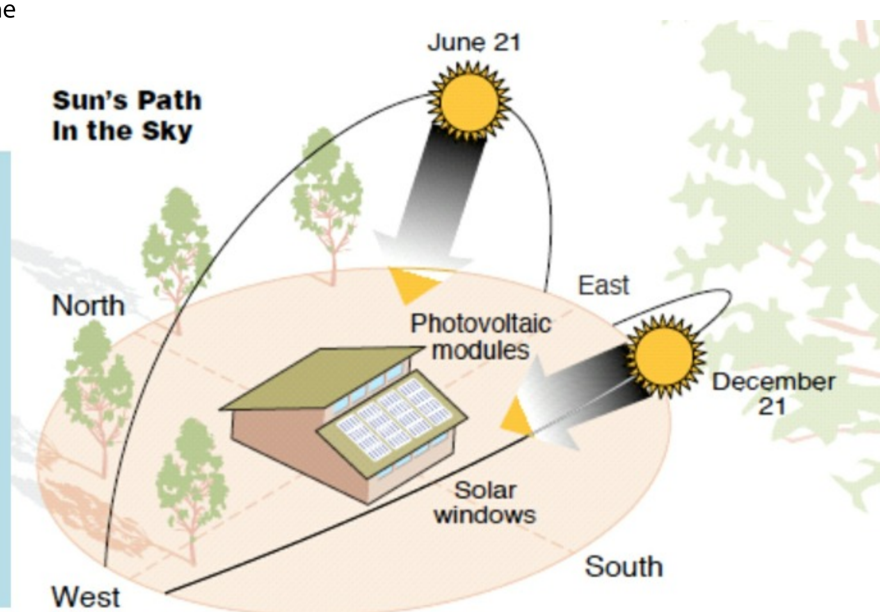
Building Systems Organization: Identify building elements which will have rooftop building implications. This includes components like elevators which require ventilation extensions or equipment overrides above the roof plane, roof access hatches or stairwells, and mechanical rooms and shafts which establish rooftop mechanical equipment. Organization of these building systems components can cause significant rooftop solar shading or inefficient array configurations if not thoughtfully placed. First, strive to minimize all rooftop impediments, secondly, organize the building systems such that what rooftop impediments must occur end up located along the Northern edge or in locations which will not cast shade on rooftop arrays. Lastly, coordinate these systems so that rooftop impediments which must occur are grouped together in the most space efficient way possible.

Building Massing: Plan the building form, building height, roof projections, etc. so that the roof area reserved for the solar array can receive a maximum amount to sun exposure. Avoid building massing schemes which result in complex, or conflicting roof sections that are prone to cast shadows on solar array locations. Avoid building massing which may result in small and irregular roof forms not conductive to the geometries of a rectilinear solar array. Contiguous, rectangular roof masses meeting the required array size will work best.

Building Orientation: Buildings should be oriented to maximize a south facing roof, or flat roof sections with quality south light access. Building orientation and configuration should maximize future solar panel access to sunlight. Buildings should be oriented with their long axis East and West, making the longest face of the building the South facing plane

Solar PV Massing Considerations

- Building orientation
- Tilt of system
- Site layout
- Shading from other structures and landscape

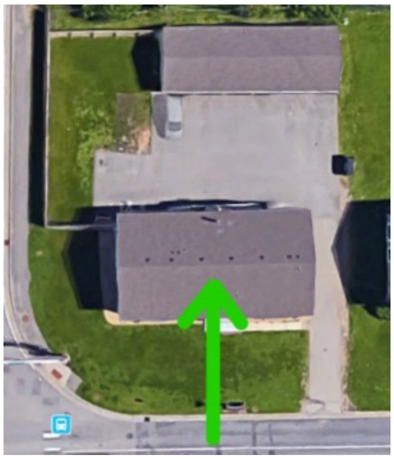


Building Form

Solar Ready Building Form (continued)

Building Massing: Plan the building form, building height, roof projections, etc. so that the roof area reserved for the solar array can receive a maximum amount to sun exposure. Avoid building massing schemes which result in complex, or conflicting roof sections that are prone to cast shadows on solar array locations. Avoid building massing which may result in small and irregular roof forms not conductive to the geometries of a rectilinear solar array. Contiguous, rectangular roof masses meeting the required array size will work best.

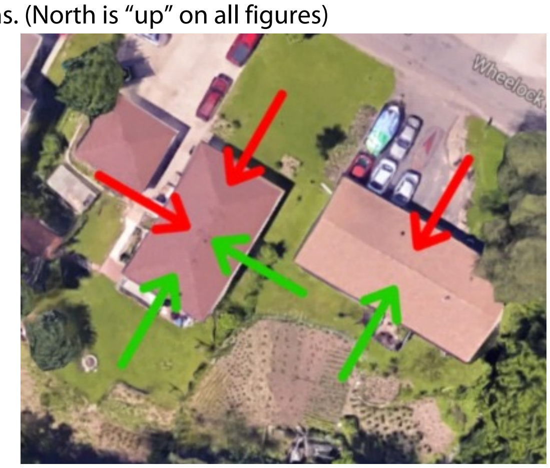
In the figures below, the building massing and roof configurations with a green arrow have good to very good solar pv potential. The roof configurations with a red arrow are likely unacceptable for cost efficient solar pv.



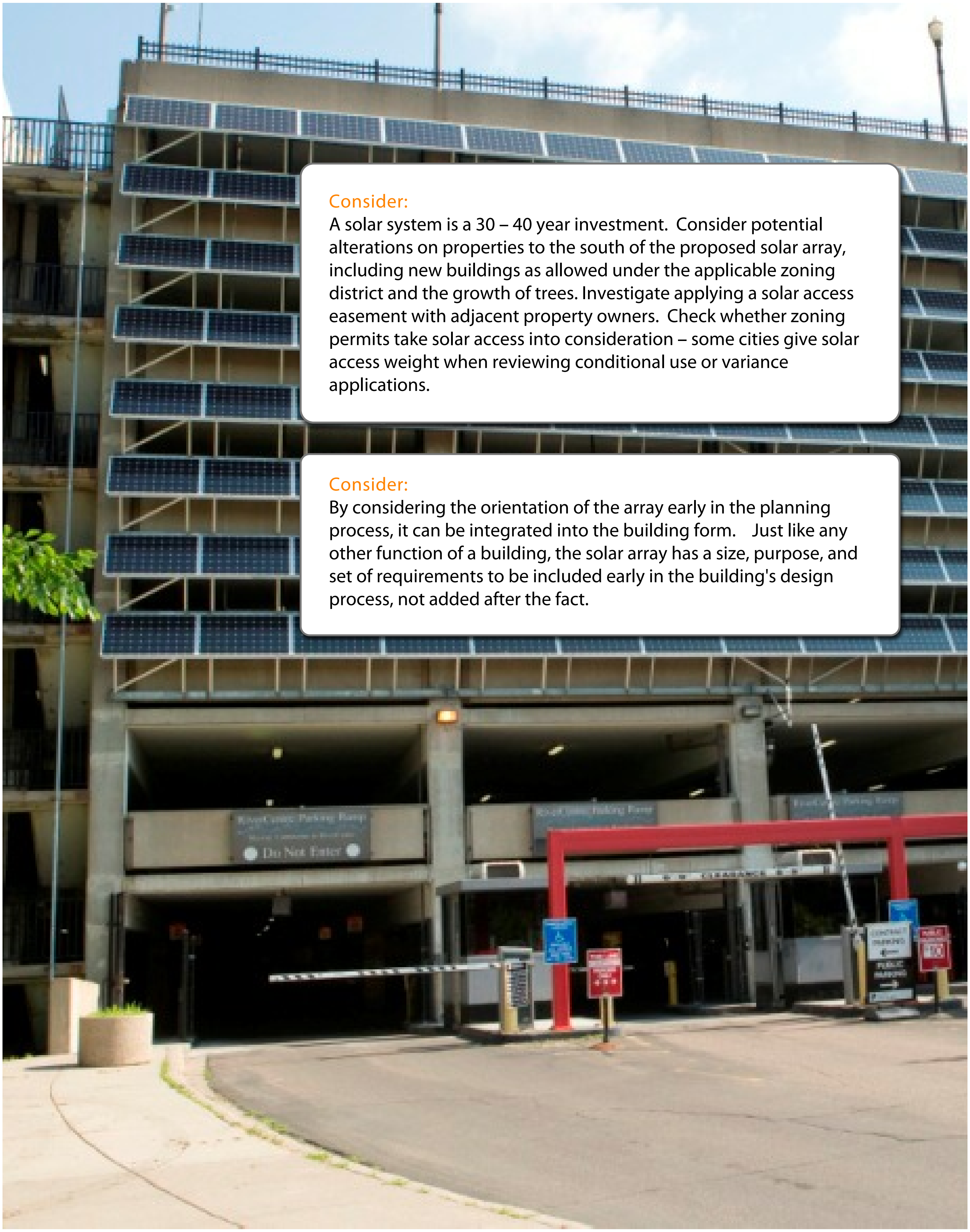
Building Orientation: Buildings should be oriented to maximize a south facing roof, or flat roof sections with quality south light access. Building orientation and configuration should maximize future solar panel access to sunlight. Buildings should be oriented with their long axis East and West, making the longest face of the building the South facing plane

In the figures below, the roof orientations with a green arrow have good to very good solar pv potential. The roof orientations with a red arrow are unacceptable solar pv roof orientations. (North is “up” on all figures)





Building Form



Consider:

A solar system is a 30 – 40 year investment. Consider potential alterations on properties to the south of the proposed solar array, including new buildings as allowed under the applicable zoning district and the growth of trees. Investigate applying a solar access easement with adjacent property owners. Check whether zoning permits take solar access into consideration – some cities give solar access weight when reviewing conditional use or variance applications.

Consider:

By considering the orientation of the array early in the planning process, it can be integrated into the building form. Just like any other function of a building, the solar array has a size, purpose, and set of requirements to be included early in the building's design process, not added after the fact.

Section 04

Roof Planning

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Roof Planning

Designate the location of the roof that has been identified as the future solar array location and provided with unobstructed solar access. Maintain this area free of obstructions or building and mechanical systems that would shade the area. The size of the solar system may not be fully known until the system is installed at some future date, consequently, maximizing the roof space that will be available for the solar collector will provide for flexibility and ease of installation. The following are considerations for solar ready roof design:

Materials

The type of roof installed when a building is built can affect installation costs when solar is pursued on the building. The type, quality, and warranty of the roof can all play a part in determining the ease of a solar install. Solar PV panels often have a 25-year warranty. It is important to install a roof that will last at least as long. Also, the type of roof chosen can determine whether roof penetrations will have to be made, which may void the roof warranty.

- For flat roofs, membrane roofing is preferred. Built up roofing systems can be accommodated, however these roofing systems must cure for 2-3 years prior to installing the solar array. Other membrane roofs can also work well with solar such as ethylene propylene diene monomer (EPDM) or polyvinyl chloride (PVC). It is important to avoid river rock ballasted membrane roofs. Removing the ballast to install solar panels can be tedious and costly.
- For sloped roofs, standing seam metal roofing is preferred and asphalt roofing can easily be accommodated. Tile roofs are not desirable unless a building integrated solar shingle is planned.

Roof Pitch and Panel Mounting

Plan the building so that a suitable, contiguous flat or properly sloped roof plane facing south or southwest is available.

- On flat roofs a rack system will always be used - the solar installer will balance between the pitch of the panel and the distance between rows to best utilize available roof area.
- A shallower pitch favors the summer sun, when the more solar exposure is best. For a PV system pitch less than 30º but greater than 15 degrees, there is only a minimal loss of annual solar power generation. Snow shedding will likely be a bigger issue with shallower sloped roofs.
- On pitched roofs, plan for solar panels to be installed close to the roof and at the same angle as roof, when at all practical.

Safety Equipment

Regardless of the location of the solar system, always consider appropriate safety measures. Maintenance, repairs, or inspections of the solar system require that a safety plan be developed. If the system is on a sloped roof, the building may need to be outfitted with a harness connection point. Additionally, fire code may require space around the edge of the roof where panels cannot be installed to allow safe access to all areas of the array.

There are no national requirements for lightning protection of solar systems, but some organizations and state and local governments have internal requirements that should be considered during the design and construction of the building.

Roof Structure

If the solar system is to be located on the roof of a building, roof structures must be designed to accommodate the additional dead loads (static load) and live loads (dynamic load) of the PV system. Figure 1 on the following page illustrates the difference between live loads and dead loads. In the figure, the red arrows refer to the dead loads, and the blue arrows refer to the live loads. For a PV system, the solar panels and racking will add approximately 3 pounds for each square foot of collector area. If ballasted mounting is used, this number can be significantly higher ranging from 4-6 pounds per square foot of collector area. (Note: verify roof loading requirements with your structural engineer)

In addition to the increased static load, consideration should be given to extraneous conditions that could be compounded due to a solar array (i.e., drifting snow, slow water runoff). In some cases this additional load can be many times the static load of a typical solar panel array. As mentioned above, when designing a building, it is critically important to be aware of the additional static and dynamic loads that could be imposed on the roof structure. The American Society of Civil Engineers (ASCE) international building code's chapter 7 can be used to calculate potential snow loads.

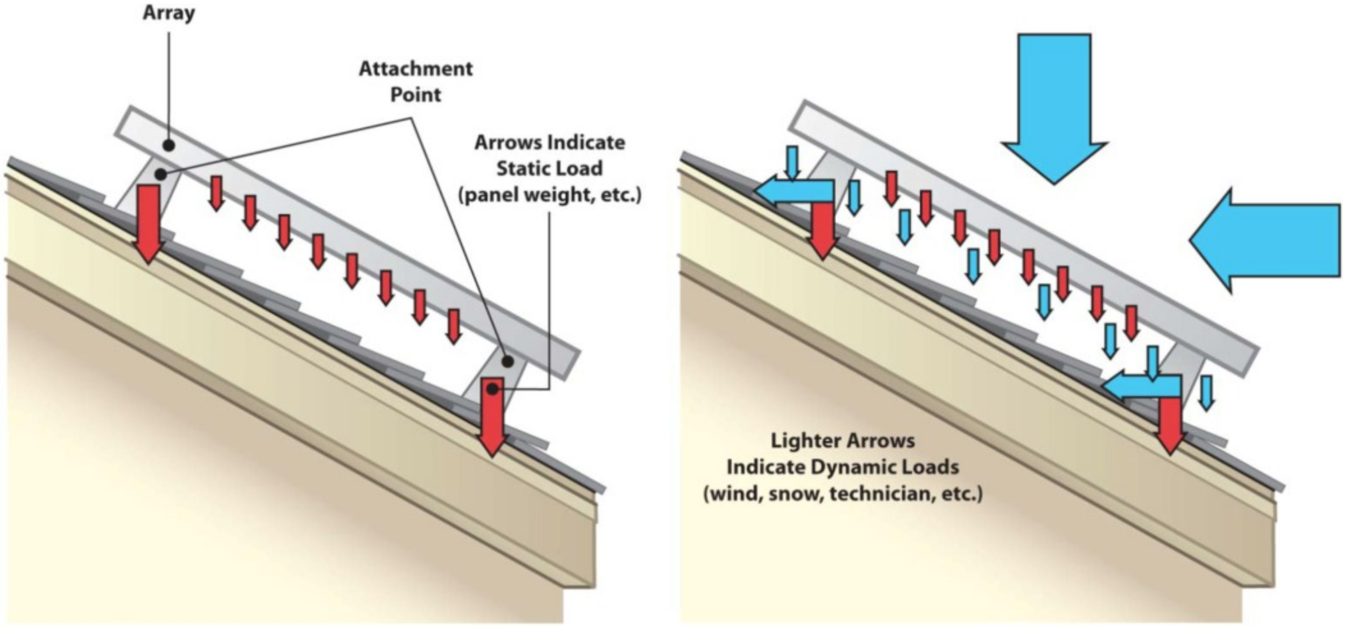

Figure 1: Live Loads vs Dead Loads (Source: National Renewable Energy Laboratory)

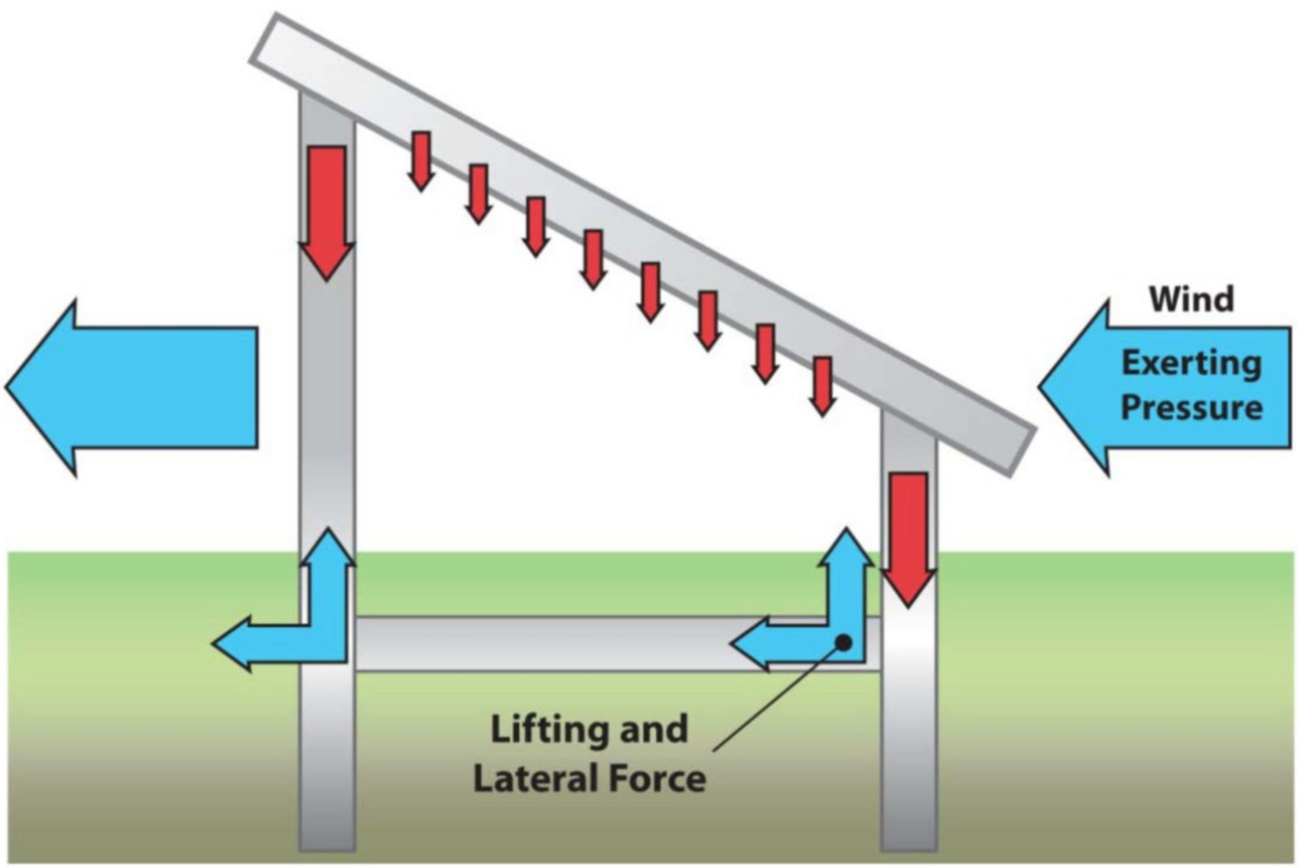

Figure 2: Wind Loading (Source: National Renewable Energy Laboratory)

Roof Planning

Wind Load

Roof structures should be designed to accommodate the dynamic loads resulting from wind interacting with the solar modules which are anticipated to be mounted on the roof. The wind load is effected by the building location, wind conditions, collector orientation, height of the exposure, and micro-conditions like the topography of the surroundings. If the collectors are flush mounted, the wind load will be comparable to the wind load occurring on the roof. Rack mounting conditions can significantly increase the wind load demands.

Figure 2 on the previous page shows the additional shear and normal forces from wind loading. There can also be a significant bending stress on the modules and roof structure that should be considered. This bending stress is normally not of significant concern, however, where flat roof trusses run parallel with the rows of solar modules and the mounting rack is designed and anchored in a specific way, a significant bending stress can result on the roof trusses.

When designing a solar ready building, it is important to be aware of these potential additional loads to ensure that the roof structure can comfortably handle all of the eventual loading conditions. Most solar panel mounting manufacturers include loading factor worksheets with their mounting hardware that can be used to calculate loads. Another resource to consult is the American Society of Civil Engineers (ASCE) international building code 7-05. Wind loading, snow loading, and other important factors are laid out in this document as well as methods to calculate these factors. Upon completing the calculations, a local solar installer or local building official should be contacted to verify the results and check the building code.

Roof Warranty

Included in most roof warranty contracts are certain terms and conditions that must be followed in order for the warranty to be valid. In some cases, a certain style of roof mount must be used in order to comply with a roof warranty contract. Whether it means using a ballasted mount, or installing a certain style of flashing at each penetration, it is important to address roof warranty questions during the design and development of the project.

Record Roof Specifications

If a roof has been designed to withstand additional loading from a solar array, it is crucial that this information is recorded so it is not lost to future solar developers. An ideal place to record this information is on the Drawing Package's Code Sheet. To support future solar pv design and installations, the construction documents for a solar ready building should clearly note the various structural loading conditions which were incorporated into the structural systems calculations related to a future solar pv installation.

Roof Warranty

In some instances, the preparation of the roof for Solar Ready Construction creates out of the ordinary roofing conditions. Verify the warranty provided by the roof manufacturer and installer includes provisions for Solar Ready Construction and will be compatible with future solar array installations without voiding coverage.


SMA
SYSTEM INSTALLED BY:
Brightergy
solar solutions
PV POWER SOURCE
DC RATINGS
(STANDARD TEST CONDITIONS)
GROUNDED "B" PHASE 240 DELTA
PV DC DISCONNECT

Section 05

Systems Planning

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Electrical and Mechanical Considerations

Electrical Panel Location

Because the PV system needs to be connected to the electrical system of the building, the electrical panel should be in a convenient location to connect to the PV array. Provide sufficient space in the electrical panel for a power input breaker. The electrical panel must have sufficiently large amperage rating to accommodate the PV energy as well as grid energy. Governed by NEC 690.64(B), the sum of the ratings of over current protection devices in all circuits supplying power to an electrical panel must not exceed 120% of the bus bar rating. When the electrical panel for the building is selected, verify that the total energy coming into the building (proposed PV system size energy generation plus grid energy) does not exceed 120% of the panel rating. Verify detailed requirements with the applicable code documents.

There must also be space available in the electrical panel for a PV circuit breaker. Near the electrical panel there should also be a convenient location for the inverter and balance of system (BOS) components, with a sufficient amount of clearance in front of the components to comply with NEC. Some of the electrical components can be located outside if necessary, but exposure to heat and the elements will reduce the performance of the components over time in some cases. Verify detailed requirements with the applicable code documents.

Grid Inter-Connection

The grid inter-connection rules are different in every state, and sometimes even vary by city. Location-specific laws should be researched. The connection requirements vary depending on what type of grid the building is connected to and what the serving utility is as most utilities will have unique interconnection requirements. The serving utility representative should be contacted to determine what rules apply to the site. If the serving utility does not allow grid-interconnection, the possibility of implementing a solar array should not be eliminated. Each year more utilities are offering grid connection for solar arrays, and it is likely that it will be offered by all utilities in the near future.

The rules and regulations associated with the grid inter-connection can be very specific, so it is important that the rules are fully understood. This process can be very time consuming, so it is beneficial to start the process well before the system is installed. A good place to get information on grid inter-connection and the various metering rules is: http://www.dsireusa.org/. Figure 3 on the following page shows the typical energy flow of a grid-tied solar PV installation. Figure 4 shows two metering configurations that are widely used. These illustrate the inter-connection configuration known as “net metering”. Net Metering is an electricity policy that allows a site with a PV system to send excess electricity to the grid and receive compensation. The compensation scheme is dependent on the servicing utility. Verify detailed requirements with the local electric utility.

Reserve Wall Space for Inverter(s): A 3’x3’ (some guides say 4’x4’) area of wall space next to the building’s main electrical panel, with an additional 3’ of clearance space in front of the wall, should be reserved for the installation of each inverter anticipated. To minimize voltage loss, the meter box and reserved inverter space should be located just below the rooftop space reserved for the solar collector. Verify detailed requirements with the applicable code documents.

Install Conduit: Metallic conduit should be installed that will run through the building from the area identified for the inverter to the area identified for the solar collector. Verify detailed requirements with the applicable code documents.

Leave Room for PV Breaker : The electric panel should include the necessary space for a power input breaker at the opposite end of the electric service panel from the main breaker. Verify detailed requirements with the applicable code documents.

Label Equipment and Reserved Spaces: Clearly label any conduit, wall space reserved, and reserved breaker space for future solar PV installation. Verify detailed requirements with the applicable code documents.

Production Meter: Provide space for a production meter to be metered off the AC system and located adjacent to Electrical Panel. The local utility may require specific production meter type for incentive programs or to qualify for Renewable Energy Credits. Requirements should be verified to assure accommodations will meet requirements.

Battery Bank: If backup energy storage, or electrical demand charge reductions are of interest for the site, designers should anticipate the potential for future battery storage. Battery technology has experienced some refinement and advancement in recent years - technological evolution should be expected to continue for energy storage systems. Consequently, the future space needs for battery banks may only be able to be estimated at best. Additionally, different battery systems, like lead acid, or lithium ion batteries, have different configurations and space requirements. With these considerations, the designer should still identify the future battery bank location and provide adequate space for the future battery bank. A reasonable rule of thumb would be to provide a 4'x4' space for every 20 Kwh of electrical storage capacity anticipated. The space should be located adjacent to the wall receiving future batteries. Verify detailed recommendations with the battery equipment manufacturer your project anticipates using.

Figure 3: Typical Energy Flow of Grid-Tied Solar PV (Source: Department of Energy)

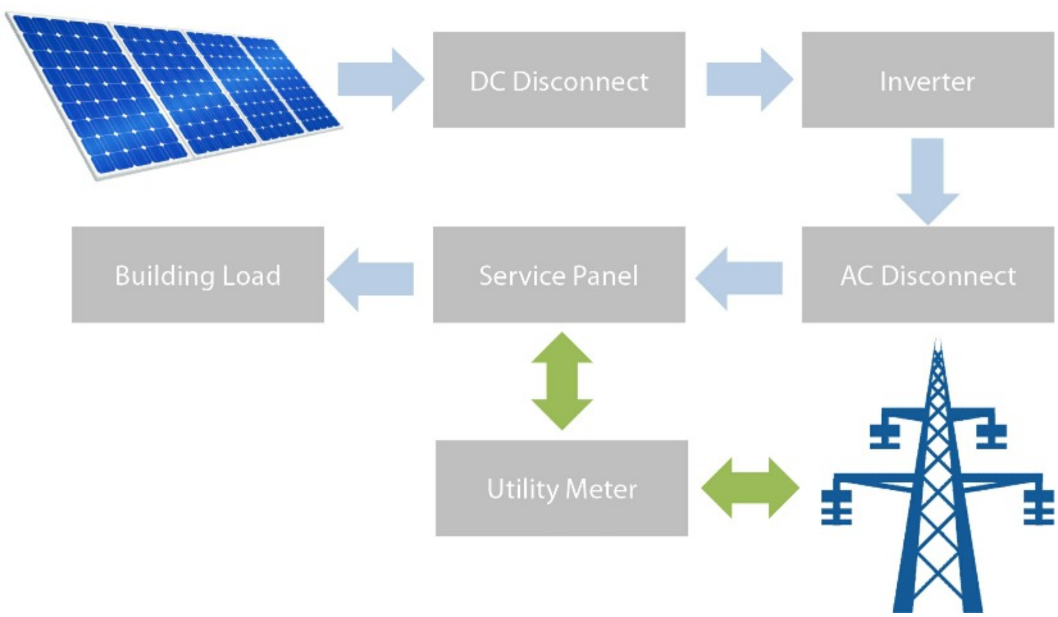
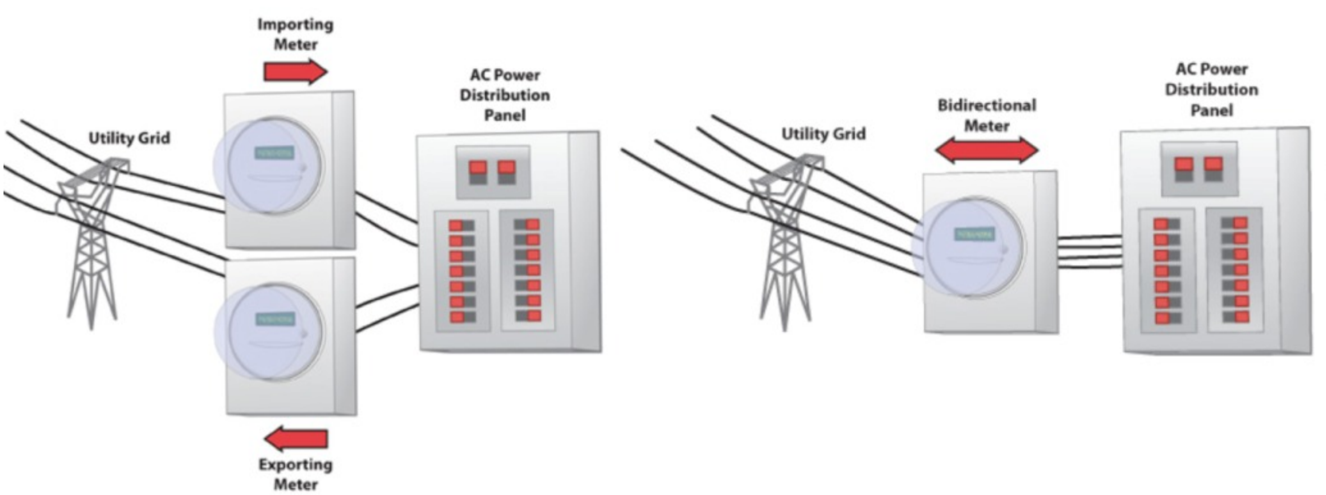


Figure 4: Dual and Bi-Directional Metering Configurations for Grid-Tied Solar PV
(Source: National Renewable Energy Laboratory)



Section 06

Codes and Permitting

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Codes and Permitting

Relevant Codes

There are various local and national codes and standards for distributed electric generator integration and interconnection with utilities. The ICC Codes are the basis for the code ordinances adopted by the State of Wisconsin, as well as most other State jurisdictions.

The International Code Council (ICC) is an organization that develops a single set of comprehensive international model construction codes focused on building safety and fire prevention. The Code publications include many provisions relevant to solar thermal and solar PV installations and the International Solar Energy Provisions (ISEP) incorporates all of the solar related provisions in one document. Also included in this summary document are NFPA National Electric Code (NEC) provisions. (http://www.solar-rating.org/press/ISEP_02-12-2015.pdf).

The 2015 IECC also includes an Appendix for residential solar-ready provisions. The 2018 IECC includes an Appendix for commercial solar-ready provisions.

The rules for use with the Wisconsin Commercial Building Code were updated on May 1, 2018. The new rules include the adoption of the 2015 IBC, IECC, IMC, IFGC & IEBC as amended by Chapters 361-366 per SPS 361.05.

> Relevant State of Wisconsin Code links can be found here:
> https://dsps.wi.gov/Pages/Programs/CommercialBuildings/Default.aspx

The International Solar Energy Provisions incorporates all code provisions for both solar PV and solar thermal in one book. This is not really a separate code and does not contain original information not included in the various ICC documents. it is a compendium of all provisions related to solar from the building, mechanical, plumbing, fire, energy, and electrical codes.

> For the International Solar Energy Provisions:
> https://shop.iccsafe.org/2015-international-solar-energy-provisions-tm-1.html

As noted, the code requirements pertaining to solar PV are found throughout many of the I-codes documents. For example, the IBC and IRC include basic information on structural requirements, material standards including rating of roof coverings, and standards for roof construction.

The International Building Code (IBC) scope covers all buildings except detached one and two family dwellings and townhouses not more than 3 stories in height. The IBC contains safety concepts, structural, and fire and life safety provisions covering means of egress, comprehensive roof provisions, and innovative construction technology. The IBC includes requirements for the fire class rating of PV systems and wind load calculations. See Chapter 15 for roof penetrations and fire classification, and Chapter 16 for structural, wind and seismic concerns.

The International Residential Code (IRC) establishes minimum regulations for one- and two-family dwellings and townhouses up to three stories. It brings together all building, plumbing, mechanical, fuel gas, and energy and electrical provisions, which include PV systems for one- and two-family residences. See Chapter 9 for roof penetrations and fire classification, and Chapter 3 for structural, wind and seismic concerns.

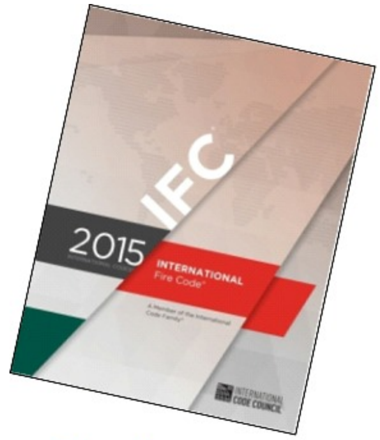
ALL solar related code requirements for PV in one place:

- Building code
- Mechanical code
- Plumbing code
- Energy code
- Fire code
- Electrical code

- Fire Classifications
- Roof Coverings
- Structural:
  - Wind
  - Seismic
  - Gravity

Codes and Permitting

The International Fire Code (IFC) includes regulations governing the safeguarding of life and property from all types of fire and explosions hazards, which include and pertain to PV systems. Topics include general precautions against fire, provisions for requirements for achieving roof access, pathways and spacing of modules and equipment for fire fighter access and smoke ventilation.



- Fire department access
- Fire safety requirements
- Requires clear space on roof for:
  - Access paths
  - Ventilation

Key Solar PV Code Safety Requirements

Anti-Islanding: Solar pv arrays must detect when the power grid “goes down” and immediately stop feeding electricity into the utility lines. This is known as anti-islanding. A grid-tied solar power system is required by law to have a grid tie inverter with an anti-islanding function, which senses when a power outage occurs and shuts itself off. NOTE: the result of this requirement is that a building with an on-site solar pv array will not receive power from the array if the utility power grid “goes down”, unless the site also has a battery bank associated with the solar array. Verify detailed requirements with the applicable code documents.

Rapid Shutdown: For fire fighter safety the National Electrical Code requires Rapid Shutdown of PV system to be installed outside the building, typically at the electrical service or the front of the building. This enables firefighters to shut down the solar pv array in case of an on-site emergency. NEC requires signage notifying presence of solar system with the location up to building official. Verify detailed requirements with the applicable code documents.

Rooftop Array Access Requirements: For commercial installations, the IFC requires a clear space at the perimeter at all roof edges as well as access pathways provided in both roof axes. The array must also provide for a clear space around standpipes, hatches, and equipment. Verify detailed requirements with the applicable code documents.

Smoke Venting: Rooftop solar arrays are limited in size before requiring intervening access pathways. The pathway requirements include venting cut-outs through the structure for firefighter smoke venting. Verify detailed requirements with the applicable code documents.

Codes and Permitting

Permitting

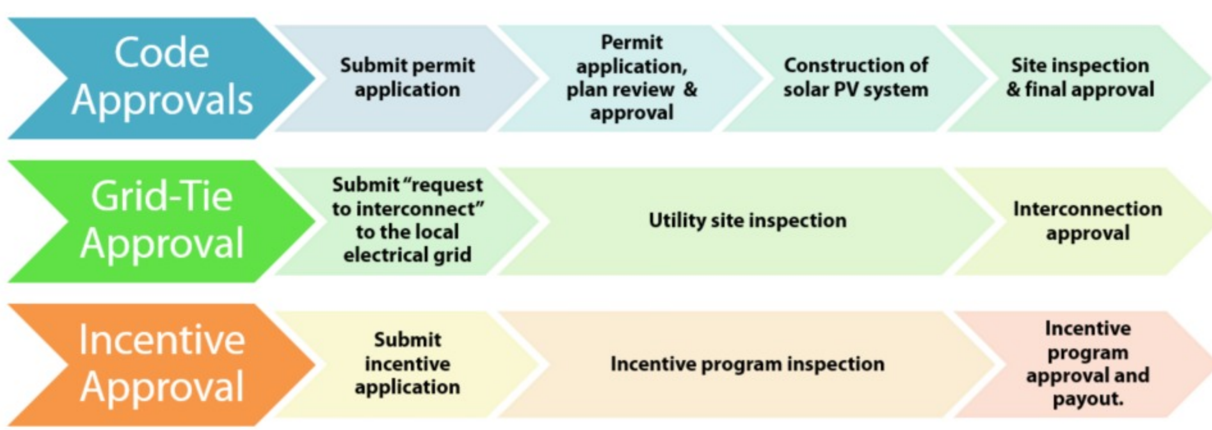
Before a solar system can be installed on a property, the system owner (or contractor on the Owner's behalf) must complete all the necessary permitting requirements. Because permitting processes often vary between jurisdictions, developers must learn about and work with each of these processes separately.

Permitting processes may involve many local, state, and federal entities—each of which has its own requirements for approval. Every distributed photovoltaic (PV) system must receive a permit from the local authority-having jurisdiction (AHJ), and utility-scale systems also often require state and/or federal permits.

Even under the simplest structure, installers must spend time preparing the permit application, submit it to the City of Eau Claire for review and then secure the permit before beginning installation. After installation, the City must send a field inspector to visually inspect the project prior to issuing approval. Generally speaking, permits take 10 days to issue. This process is faster than the average of eight weeks elsewhere. Complete building permit applications and an up-front understanding of the relevant codes and permitting process by the applicant can help ensure success.

Overlapping Permitting and Approval Process

Many solar pv installations require multiple review and approval processes. All grid-tied solar installations require at a minimum, building and electrical permit approvals as well as the utility interconnection approval. In addition to these, many installation finances are dependent on a financial incentive or renewable energy market program which will also have some form of project review and approval. A successful solar pv project should start with clearly defining all relevant review and approval processes the project will require and creating an integrated schedule in order to minimize approval process time and assure all requirements and submission deadlines are met.



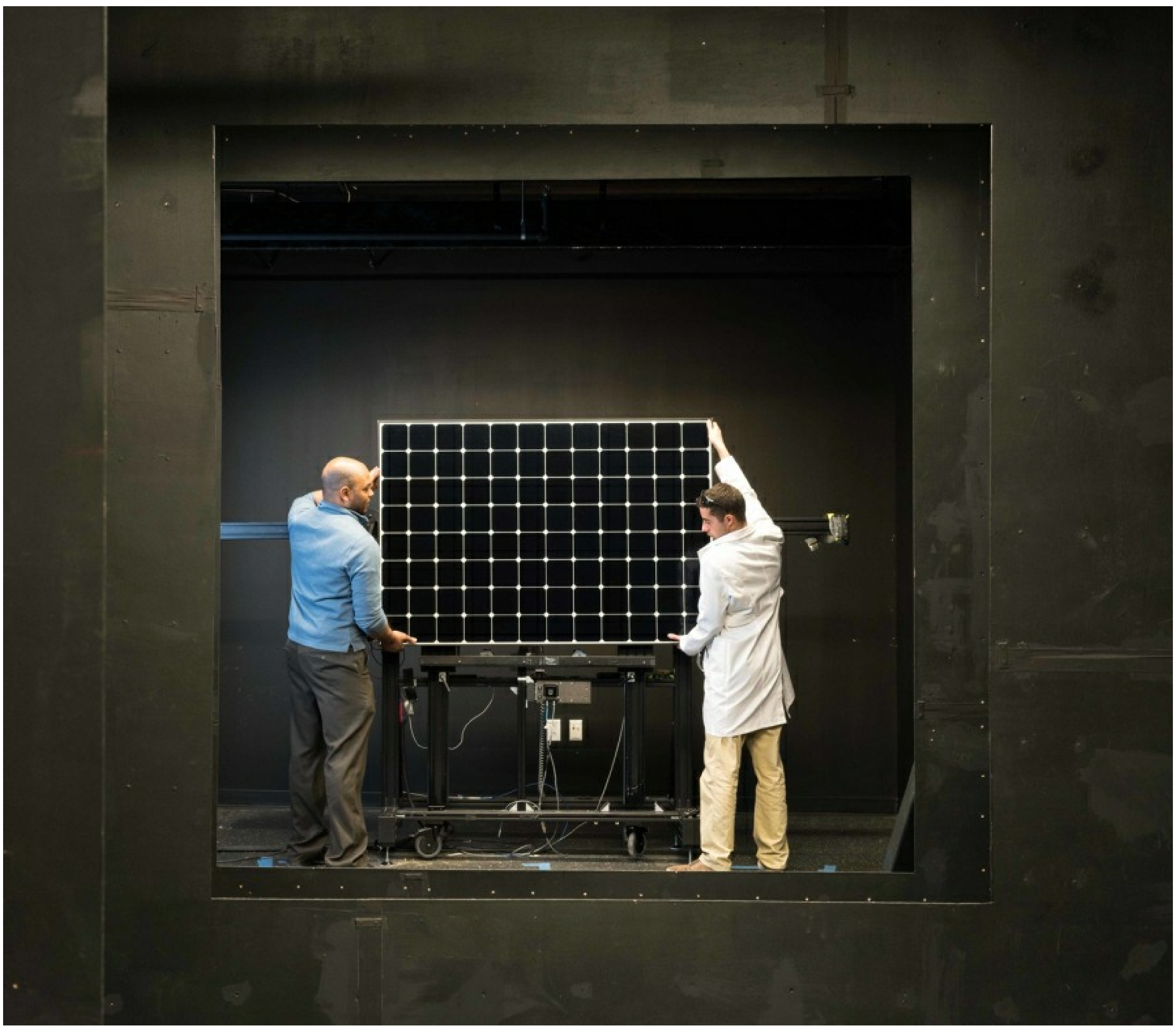
Codes and Permitting

Standards

Common standards for solar pv installations include:

- IEEE 1547 Standard for Interconnecting Distributed Resources with Electric Power Systems
- UL 1703 Standard for Flat-Plate Photovoltaic Modules and Panels
- UL 1741 Standard for Inverters, Converters, Controllers and Interconnection System Equipment for Use With Distributed Energy Resources
- Quality Standard: the California Energy Commission (CEC) maintains a list of solar pv panels, inverters, and meters which have met minimum quality standards established by the State of California. This list can be used to validate minimum quality of proposed solar pv equipment. https://www.gosolarcalifornia.ca.gov/equipment/

In addition, an engineer's stamp is recommended to determine structural weight carrying capacity of the roof and includes wind loads and final electrical design. The photovoltaic layout must also be checked to ensure compliance with fire specifications. See the NFPA NEC and the GSA Fire Safety Guideline for Photovoltaic System Installation for more information.

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Section 07

Benefits of Solar PV

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Benefits of Solar PV

Financial Benefits

Solar PV can offset your grid purchases of electricity and can reduce your monthly electric bill costs through reduced energy and demand charges. In addition, a variety of federal, state, and local incentive programs can reduce the initial cost. Finally, many third-party ownership models have been developed that increase the financial attractiveness of solar PV. All of these items are discussed in detail in the following sections.

Environmental Benefits

Installing solar PV directly offsets purchases of grid-supplied electricity. The emissions offsets of doing so will vary depending on your location, but it will generally result in reduced carbon dioxide (CO2), nitrous oxide (NOX), sulfur oxide (SOX), and particulate matter (PM) emissions from the combustion of fossil fuels in natural gas-and/or coal-fired power plants. For detailed information on local emissions profiles, refer to the EPA's Emissions & Generation Resource Integrated Database (eGRID), a comprehensive source of data on the environmental characteristics of almost all electric power generated in the United States. Increasing use of Solar PV for electricity generation within the community will offer additional indirect benefits, namely the reduction of Greenhouse Gas emissions (GHG) and the reduction of fresh water use.

Greenhouse Gas and Electricity

Greenhouse gas emissions form, primarily, from the burning of fossil fuels. The carbon footprint of electricity is the total greenhouse gas emissions throughout the life-cycle from source fuel extraction through to end user electricity. According to the Intergovernmental Panel on Climate Change (IPCC), the median greenhouse gas emission, measured in metric tonnes, for 1 Gwh of electricity by fuel type is as follows:

Electricity Source	Metric Tonnes GHG/MWh
Hydroelectric	.004
Wind	.012
Nuclear	.016
Biomass	.018
Geothermal	.045
Solar PV	.046
Natural gas	.469
Coal	1.001

The Water/Energy Nexus

Water and energy are inextricably linked in our current modern infrastructure. Water is used in all phases of energy production. Energy is required to extract, pump and deliver water for use, and to treat waste-water so it can be safely returned to the environment. The cumulative impact of electricity generation on our water sources can be significant, and varies by fuel source. According to The River Network, the average fresh water use for 1 Gwh of electricity by fuel type is as follows:

Electricity Source	Gallons/MWh
Hydroelectric	29,920
Wind	1
Nuclear	2,995
Biomass	2
Geothermal	2
Solar PV	2
Natural gas	1,512
Coal	7,143

Additional Benefits of Commercial Solar PV:

Receive Tax Credit

The Incentive Tax Credit will provide a Federal tax credit for a portion of the solar pv installation costs – this includes building upgrades required for the installation such as roof replacement. The ITC credit is equal to 30% of the project costs in 2019 and will be stepping down to 10% by year 2022 and beyond.

Depreciation Tax Benefit

The Modified Accelerated Cost Recovery System (MACRS), established in 1986, is a method of depreciation in which a business' investments in certain tangible property are recovered, for tax purposes, over a specified time period through annual deductions. Qualifying solar energy equipment is eligible for a cost recovery period of five years. If the ITC was claimed for the system, then the owner must reduce the depreciation basis by one-half the value of the ITC. This means the owner is able to deduct 85% to 95% of his or her tax basis. The market certainty provided by MACRS has been found to be a significant driver of private investment for the solar industry and other energy industries.

Solar is exempt from property tax

Legislation was enacted in 2007 (Wis. Stat. § 77.54(56)) to exempt products whose power source is from solar radiation. Questions should be directed to the Wisconsin Department of Revenue and property tax exempt form can be found at: https://www.revenue.wi.gov/DORForms/pr-303.pdf

Reduce Operating Costs

Solar power systems will reduce or even eliminate your office building's electric bill. EnergySage Marketplace Data indicates the average commercial property owner's electric bill drops 75% - from $1,950 to %500 – after switching to solar.

Benefits of Solar PV

Additional Benefits of residential solar pv:

It's a solid home investment

A study by Lawrence Berkeley National Laboratory showed that across the board, buyers were willing to pay $15,000 extra for a home with an average-sized solar panel system. An additional study by Zillow reported that the average home with solar sold for 4-7% more than its neighbors.

Solar has a fixed energy cost

Nationally, electricity costs rise an average of 2.5% annually. The cost for a solar system, on the other hand, remains the same. Whether you choose to lease or finance your system, then you have a set, minimal monthly payment that replaces your electricity bill.

Solar can actually make you money

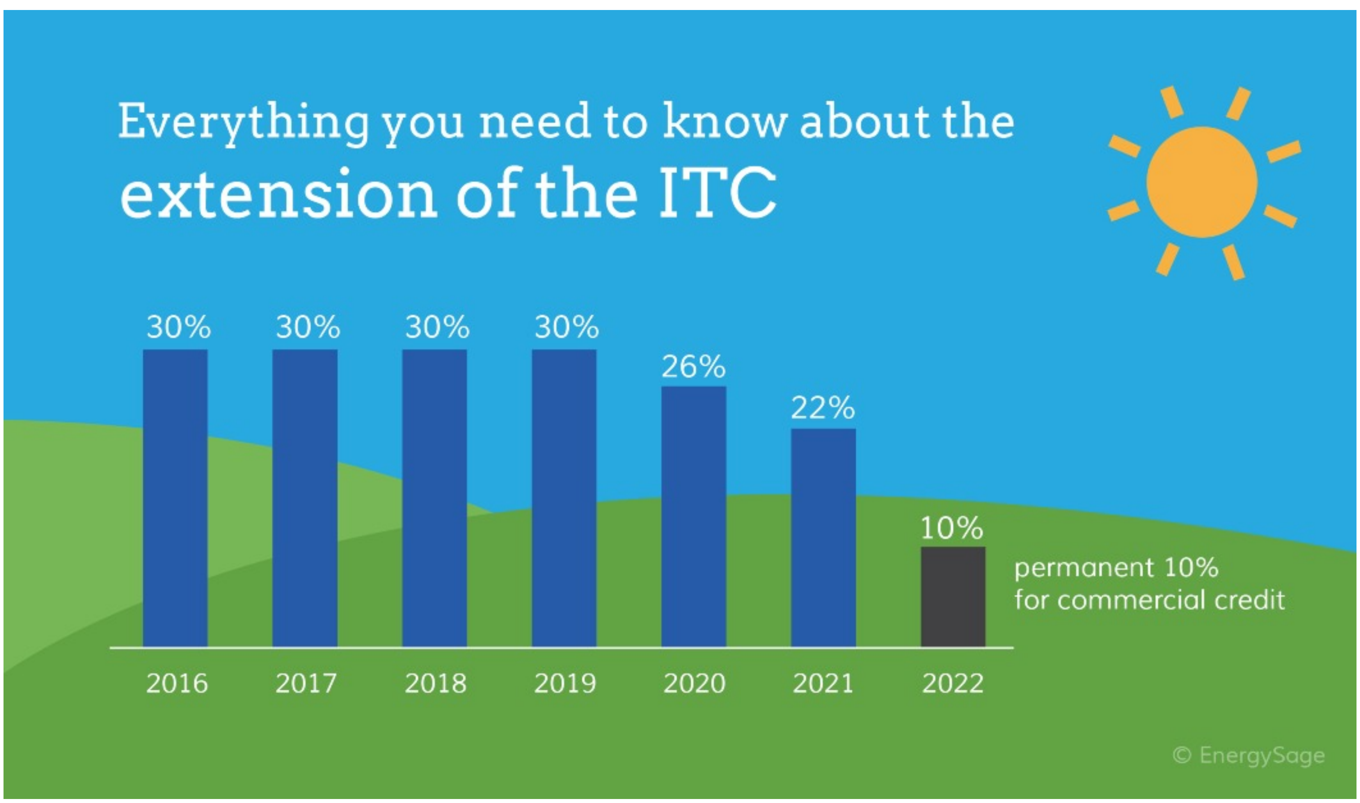
The State of Wisonsin's Renewable Portfolio Standard (RPS) requires utilities to secure 10% of their electricity from renewable sources, meaning utilities have an incentive to encourage solar!

You can use your Solar Energy all day

Solar energy is generated from daylight, not sunlight. So even on cloudy days, your panels will be producing energy. With Wisconsin's Net Metering law, any excess energy generated during the day is pushed back onto the grid, crediting your account. Then, in the evening hours, you will be using the energy credited from the meter.

Solar is exempt from property tax

Legislation was enacted in 2007 (Wis. Stat. § 77.54(56)) to exempt products whose power source is from solar radiation. Questions should be directed to the Wisconsin Department of Revenue and property tax exempt form can be found at: https://www.revenue.wi.gov/DORForms/pr-303.pdf



Benefits of Solar PV

Marketing Benefits

Solar PV is a highly visible asset that has several marketing benefits:

- Earn the "Green" Label: Using solar power reduces your business's consumption of fuels, reducing greenhouse gas emissions and pollution. Any business using solar is helping to reduce global warming and increase the country's energy independence. Going solar not only reduces expenses but is also great PR
- If you have corporate or organizational sustainability goals, solar PV will help you meet your targets
- For federal, state, and local buildings, you may have clean energy or sustainability targets that solar PV will help you to achieve
- For commercial buildings that lease floor space, your tenants may value the presence of solar PV, and you may be able to pass this value on through the lease price
- If you have a commercial building and your target market values sustainability and environmental issues, solar PV can be included in your advertising efforts
- For schools and other educational buildings, solar PV can be used as an educational tool to teach students about solar energy and sustainability

Other Benefits

Solar PV has other benefits beyond those stated above, which may not be applicable to every building:

- Reliability –If solar PV is part of a microgrid that you are installing at your facility, it can help power your building during an outage or when disconnected from the grid. Alternatively, if you do not have a microgrid system but would like your PV to be available during an outage, you can work with your designer/installer to assess the feasibility and costs of this.
- Cooling Load Reduction –Adding solar PV to a roof will reduce your buildings cooling load. If solar PV is installed as a canopy, it will provide shading. Both of these configurations reduce the urban heat island effect.
- LEED Credentials –If you are seeking to obtain LEED certification from the U.S. Green Building Council 13, solar PV counts toward several of the credit categories.

Section 08

Additional Resources

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Additional Resources

Websites

- DOE's EERE Solar Photovoltaics Technology Basics gives a brief description of how the photovoltaic materials convert sunlight into electrical energy.
  https://www.energy.gov/eere/solar/articles/solar-photovoltaic-technology-basics
- Database of State Incentives for Renewables & Efficiency (DSIRE) provides a comprehensive list of federal, state, and local incentives that promote renewable energy and energy efficiency.
  http://www.dsireusa.org/
- Go Solar California has information about the PVUSA Test Conditions energy production of most modules.
  https://www.gosolarcalifornia.org/equipment/pv_modules.php
- North American Board of Certified Energy Practitioners (NABCEP) provides an industry certification of experienced photovoltaic installers. NABCEP was designed to raise industry standards and promote consumer confidence in photovoltaic and solar thermal system installations.
  https://www.nabcep.org/
- National Center for Photovoltaics (NCPV) focuses on innovations in photovoltaic technology that drive industry growth in photovoltaic manufacturing nationwide. Formed by the U.S. Department of Energy (DOE) and based at NREL, the NCPV focuses on research and development and increasing U.S. competitiveness.
  https://www.nrel.gov/pv/national-center-for-photovoltaics.html
- NREL's PVWatts calculator determines the energy production and cost savings of grid-connected photovoltaic energy systems throughout the world. Version 1 allows you to select a location from a map or text list of pre-determined locations. Version 2 allows you to select any location in the United States.
  https://pvwatts.nrel.gov/
- Procuring Solar Energy: A Guide for Federal Facility Decision Makers provides an overview of federal facility managers and their procurement terms on the process of installing solar electric and solar thermal systems.
  https://www1.eere.energy.gov/solar/pdfs/47854.pdf
- Sandia National Laboratories teams with the U.S. Department of Energy, industry, and academia to improve the performance and reliability of photovoltaic technologies and grid integration.
  https://energy.sandia.gov/energy/renewable-energy/solar-energy/photovoltaics/
- Rocky Mountain Institutes Best Practices for Leasing Net Zero Energy Buildings offers important considerations for commercial buildings which are leased to sub-tenants
  https://rmi.org/wp-content/uploads/2018/01/RMI_NZE_Lease_Guide.pdf

Organizations

- American Solar Energy Society is the nation's leading association of solar professionals and advocates. It lends a resource listing solar businesses within each state.
  https://www.ases.org/
  https://www.ases.org/our-community/business-members/
- Smart Electric Power Alliance provides information about solar technologies, policies, and programs.
  https://sepapower.org/
- Solar Energy Industries Association is the national trade association of the solar energy industry and also includes information regarding solar installations and solar manufacturers and installers by state.
  https://www.seia.org/

Publications

- Freeing the Grid, Best Practices in State Net Metering Policies and Interconnection Procedures, 2011 Edition , GRACE Communications Foundation
- *On-Site PV Guidance*—Appendix G: GSA Fire Safety Guideline for Photovoltaic System Installations , prepared jointly by the General Services Administration and the National Renewable Energy Laboratory
- Technology Roadmap, Solar Photovoltaic Energy , 2014 Edition, International Energy Agency
- U.S. Solar Market Insight Report 2011 Year in Review, Solar Energy Industries Association

Training Courses

- FEMP07 Selecting, Implementing, and Funding Photovoltaic Systems in Federal Facilities
  https://www.wbdg.org/continuing-education/femp-courses/femp07

Section A1

Sustainability for Historic Buildings (Solar Excerpt)

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Sustainability for Historic Buildings

https://www.nps.gov/tps/standards/rehabilitation/sustainability-guidelines.pdf

As of 2019, according to the Wisconsin Historical Society, there are 66 buildings in the City of Eau Claire registered on either or both of the State and National Register of Historic Places. Renovating historic properties to achieve Net Zero Energy or improved sustainability must be carefully planned in order to preserve the historic aspects of the building.

Preserving a building is often called the ultimate recycling project. Historic buildings were traditionally designed with many sustainable features that responded to climate and site. When effectively restored and reused, these features can bring about substantial energy savings. Taking into account historic buildings' original climatic adaptations, today's sustainable technology can supplement inherent sustainable features without compromising unique historic character.

The following are excerpts from "The Secretary of The Interior's Standards for Rehabilitation & Illustrated Guidelines on Sustainability for Renovating Historic Buildings". These strategies provide guidance for solar pv retrofit of historic structures.

Solar Technology Strategies

RECOMMENDED	NOT RECOMMENDED
Considering on-site, solar technology only after implementing all appropriate treatments to improve energy efficiency of the building, which often have greater life-cycle cost benefit than on-site renewable energy.	Installing on-site, solar technology without first implementing all appropriate treatments to the building to improve its energy efficiency.
Analyzing whether solar technology can be used successfully and will benefit a historic building without compromising its character or the character of the site or the surrounding historic district.	Installing a solar device without first analyzing its potential benefit or whether it will negatively impact the character of the historic building or site or the surrounding historic district.
Installing a solar device in a compatible location on the site or on a non-historic building or addition where it will have minimal impact on the historic building and its site.	Placing a solar device in a highly-visible location where it will negatively impact the historic building and its site.
Installing a solar device on the historic building only after other locations have been investigated and determined infeasible.	Installing a solar device on the historic building without first considering other locations.
Installing a low-profile solar device on the historic building so that it is not visible or only minimally visible from the public right of way: for example, on a flat roof and set back to take advantage of a parapet or other roof feature to screen solar panels from view; or on a secondary slope of a roof, out of view from the public right of way.	Installing a solar device in a prominent location on the building where it will negatively impact its historic character.
Installing a solar device on the historic building in a manner that does not damage historic roofing material or negatively impact the building's historic character and is reversible.	Installing a solar device on the historic building in a manner that damages historic roofing material or replaces it with an incompatible material and is not reversible.
	Removing historic roof features to install solar panels.
	Altering a historic, character-defining roof slope to install solar panels.
	Installing solar devices that are not reversible.
Installing solar roof panels horizontally -- flat or parallel to the roof—to reduce visibility.	Placing solar roof panels vertically where they are highly visible and will negatively impact the historic character of the building.

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